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Integration of Fuzzy AHP and TOPSIS for Assessing the Intellectual Capital Capability in Tire Industry

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ABSTRACT

Managing the intangible assets like Intellectual capital (IC) has been widely considered as a fundamental tool to gain and maintain competitive advantage. According to this, the present study proposes a multiple criteria approach to rank companies based on their IC capability. We use fuzzy AHP method to determine the weights of the criteria. The companies are then ranked according to IC capability indicators by TOPSIS method.

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1. Introduction

During the last decade managing the intangible assets like Intellectual capital (IC) have been widely considered as a fundamental tool to gain and maintain competitive advantage. Indeed, the traditional accounting methods can not estimate the true value of the organizations in today's intensive knowledge environment (Calabrese, Costa, & Menichini, 2013). In this situation IC concept has become an important issue. After introducing, developing definitions and increasing attention to IC in 1990s, authors started to focus on measurement, modeling and case studies in this field of research after the year 2000(Mehralian, Rasekh, Akhavan, & Ghatari, 2013). Although almost a lot of conceptual frameworks were developed in order to classify the main IC categories, as the field matured, three common categories emerged as the most useful ones for describing the construction of IC and these are organizational (or structural) capital, relational (or customer) capital and human capital (Campbell & Abdul Rahman, 2010). Thus as the first contribution of this paper, by considering the above categorization we extract the Main attributes of each IC category and their relative indicators based on an extensive literature review. Many researchers have implied the importance of prioritizing IC attributes in the situation of resource scarcity in order to overcome the problem of overestimating some of them or neglecting others (see e.g., Bozbura et al., 2007; Lee, 2010; Dong & Gao, 2012; Calabrese et al., 2013). In the real world, many IC attributes are intangible in nature and quantitative measuring of them is difficult or impossible. For this reason, experts need linguistic terms to provide intangible IC assessments based on their opinions (Calabrese et al., 2013). Therefore the second contribution of this study is to prioritize the most important attributes of IC in the Tire Industry through the adaptation of fuzzy AHP. The prioritizing and likely selecting the IC measurement attributes and finally comparing some organizations based on the most important IC attributes are multi-criteria decision making (MCDM) problems which need different experts' judgments. In other words, the MCDM methodologies allow the comparison among companies in the same industry based on selected or weighted IC attributes. Therefore as the third contribution, this study applies TOPSIS method in order to compare and rank different companies in the Tire Industry based on their IC capability. The paper is organized as follows. Section 2 provides a complete literature review on definition of IC and its three categories. It is followed by discussing the main attributes of each IC category and their relative indicators for the purpose of measuring the IC capability. Section 3 describes the research methodology. The procedures of fuzzy AHP and TOPSIS as two proper MCDM methods are presented to determine the relative weights of each IC attribute and ranking companies based on them. Section 4 includes the data analysis and results of applying the above methods for assessing the IC capability of 3 Iranian companies in Tire Industry and finally conclusions are given in the last section.

2. Literature Review

2.1. Intellectual Capital Definition

IC is an intangible asset of a company that is difficult to estimate by traditional financial reports (Mehralian et al., 2013). The terms "intangible assets" and "intellectual capital" are being used interchangeably and both of them describe the sources for creating long term value in an organization (Campbell & Abdul Rahman, 2010). Different definitions for IC have been presented by the researchers in this field. For example Roos, Dragonetti and Edvinsson (1997) referred to IC as sum of the knowledge of organization members and the practical translation of this knowledge. According to edvinsson and Malone (1997) IC is the information and knowledge that are applied to work for creating value. Stewart (1999) defined IC as a resource that comes from the knowledge, experience and competencies of the employees, from the organization's infrastructure and its ability to innovate and finally from the relationships between stakeholders and partners. It seems that an agreed definition for IC is elusive because different authors define it in terms of different categories. Edvinsson and Sullivan (1996) and Roos et al. (1997) divided IC into human capital and structural capital. Then Edvinsson and Sullivan (1996) sub-categorized structural capital into organizational capital, customer capital and relationship capital. Roos et al. (1997) also devided structural capital into three sub- categories organization, Relationships and Renewal and development. Liebowitz and Wright (1999) implied to four unique categories such as human capital, customer capital, process capital and innovation capital as IC categories. Despite the differences, three common categories have emerged and known as the most useful categories for describing the IC construct.These are human capital,organizational (or structural) capital and relational (or customer) capital. (see e.g.,Bontis, 1998; Bukh, Larsen, & Mouritsen, 2001; Bozzolan, Favotto, & Recceri, 2003; Guthrie, Petty, Yongvanich, & Ricceri, 2004).
The three main categories that comprise the IC construct have been defined in the litreture as follows:

1. Human capital is the individual-level knowledge of employees that can provide the most valuable assets (Stewart, 1999). Organizations should recruit, develop and retain this element of Intellectual assets to gain sustainable competitive advantages(Mehralian et al., 2013).
2. Structural capital comprises mechanisms and structures that are essential to support employees and convert individual human assets into group assets. Unlike human capital which cannot be owned by the company, structural capital is the characteristic of the firm that can be reproduced within the firm. (Mehralian et al., 2013).
3. Relational capital is the sum of all assets that manage the networks and relations of an organization with its environment (Lee, 2010). It also focuses on how firms can absorb knowledge from their environment in order to provide sustainable competitive advantage (Mehralian et al., 2013).

2.2. Intellectual Capital Measurement

Many factors can be found in the literature for the purpose of measuring each of the IC categories. The Main attributes of each IC category are detailed in Table 1.

Table 1. Main attributes and indicators of Intellectual capital

Main attributes of each IC category	Examples of Indicators	Referances
Human capital		
1. Education	University degree Professional qualification	Shih, liu, Jones and Lin(2010); Abeysekera and Guthrie(2004); Bozbura and Beskese(2007); Mehralian et al., (2013); Campbell and Abdul Rahman(2010)
2. Work Related Knowledge	Know how Work related Experience Seniority	Baxter and Matear(2004); Bozbura and Beskese (2007); Shih et al.(2010); Abeysekera and Guthrie (2004); Mehralian et al., (2013); Campbell and Abdul Rahman(2010)
3. Employee Skills	Technical/ Professional skills Teamwork skills Risk taking skills Problem solving skills Communication skills	Baxter and Matear (2004); Bozbura(2004); Bozbura, Beskese and Kahraman (2007); Shih et al.(2010); Abeysekera and Guthrie (2004); Bontis(1998); Bontis, Keow and Richardson(2000); Suraj and Bontis(2012); Mehralian et al. (2013); Campbell and Abdul Rahman(2010)
4. HR Activities	Recruitment programs Equal opportunities Employee safety Employee relationship Employee retention Training programs Continuing education for employee Career and Vocational development Former staffs as consultants	Bozbura(2004); Bozbura et al.(2007); Abeysekera and Guthrie (2004); Bontis(1998); Bontis et al.(2000); Suraj and Bontis(2012); Campbell and Abdul Rahman(2010); Mehralian et al., (2013); Tai and Chen (2009); Calabrese et al. (2013)

	Employee compensation plans Employee thanked/featured	
5. Innovation	Creativity Innovativeness New ideas	Baxter and Matear (2004); Bozbura(2004); Abeysekera and Guthrie (2004); Bontis (1998); Bontis et al.(2000); Suraj and Bontis (2012); Campbell and Abdul Rahman(2010)
6. Employee Attitude	Eagerness to source sharing Employee satisfaction Perform their best Being ethical Enthusiasm for working with org. Commitment Emotional stability Conscientiousness Continuous learning Personal initiative	Shih et al.(2010); Baxter and Matear(2004); Bontis (1998); Bontis et al.(2000); Bozbura (2004); Bozbura et al.(2007); Suraj and Bontis (2012); Mehralian et al., (2013); Campbell and Abdul Rahman(2010)
7. Management and Leadership	Leadership ability of management level Experience of managers in organization	Bozbura (2004);Bozbura et al.(2007); Mehralian et al., (2013)
Structural capital		
1. Intellectual Properties	Brand Patent Trademark Copyright Internet domain name	Bozbura(2004); Baxter and Matear(2004); Tai and Chen (2009); Mehralian et al. (2013); Campbell and Abdul Rahman(2010)
2. Organization Philosophy and Strategic Values	Vision Mission Code of ethic Code of conduct Create value for shareholders Principles	Bozbura(2004); Bozbura and Beskese (2007); Campbell and Abdul Rahman(2010)
3. Organizational Climate	Atmosphere is supportive Supports development of ideas	Bontis(1998); Bontis et al.(2000); Suraj and Bontis (2012); Bozbura(2004); Bozbura and Beskese (2007); Mehralian et al. (2013); Calabrese et al. (2013)
4. Organizational Structures, Systems and Procedures	Procedures support innovation Management information systems Control stock Quality control Research and development	Bozbura(2004); Bozbura and Beskese (2007); Tai and Chen (2009); Mehralian et al. (2013); Calabrese et al. (2013); Campbell and Abdul Rahman(2010)
5. Information Technologies and Network Systems	Intranet Scientific data bases Specific software	Bozbura(2004); Bozbura and Beskese (2007); Baxter and Matear(2004); Mehralian et al. (2013); Campbell and Abdul Rahman(2010)
6. Infrastructures	Machines Plants PCs	Mehralian et al. (2013); Campbell and Abdul Rahman(2010)
Relational capital		
1. Customers	Customers' satisfaction Customers' trust Customers' complaints Customers services Customers loyalty No. of customers Relationships with customers	Bontis(1998); Bontis et al.(2000); Suraj and Bontis (2012); Bozbura(2004); Baxter andMatear(2004); Tai and Chen (2009); Mehralian et al. (2013); Calabrese et al. (2013); Campbell and Abdul Rahman(2010)
2. Distribution Channels	Supply chain Business network	Mehralian et al. (2013); Campbell and Abdul Rahman(2010)

3. Business Partnering	Strategic cooperation Suppliers Investors Consultants	Baxter and Matear(2004); Mehralian et al. (2013); Campbell and Abdul Rahman(2010)
4. Organization Reputation	Social responsibilities Relationship with public institution	Mehralian et al.(2013); Campbell and Abdul Rahman(2010)

3. Research Methodology

3.1. Process and Framework

The main purpose of this study is developing an intellectual capital evaluating model in order to assess and compare the IC capability of companies in Tire industry. According to this, first by studying the literature related to intangible capitals, the main IC categories, attributes and their related indicators was recognized. Semi-structural interviews with scholars and managers of 3 companies which were going to rank based on their IC capability, validated the framework of the study and the attributes chosen as our sub-criteria. Then the weight of each IC criterion was analyzed by the fuzzy AHP method. Finally, according to these weights, the TOPSIS method was applied for the purpose of ranking companies. The hierarchy designed for our analysis illustrated in Figure 1.

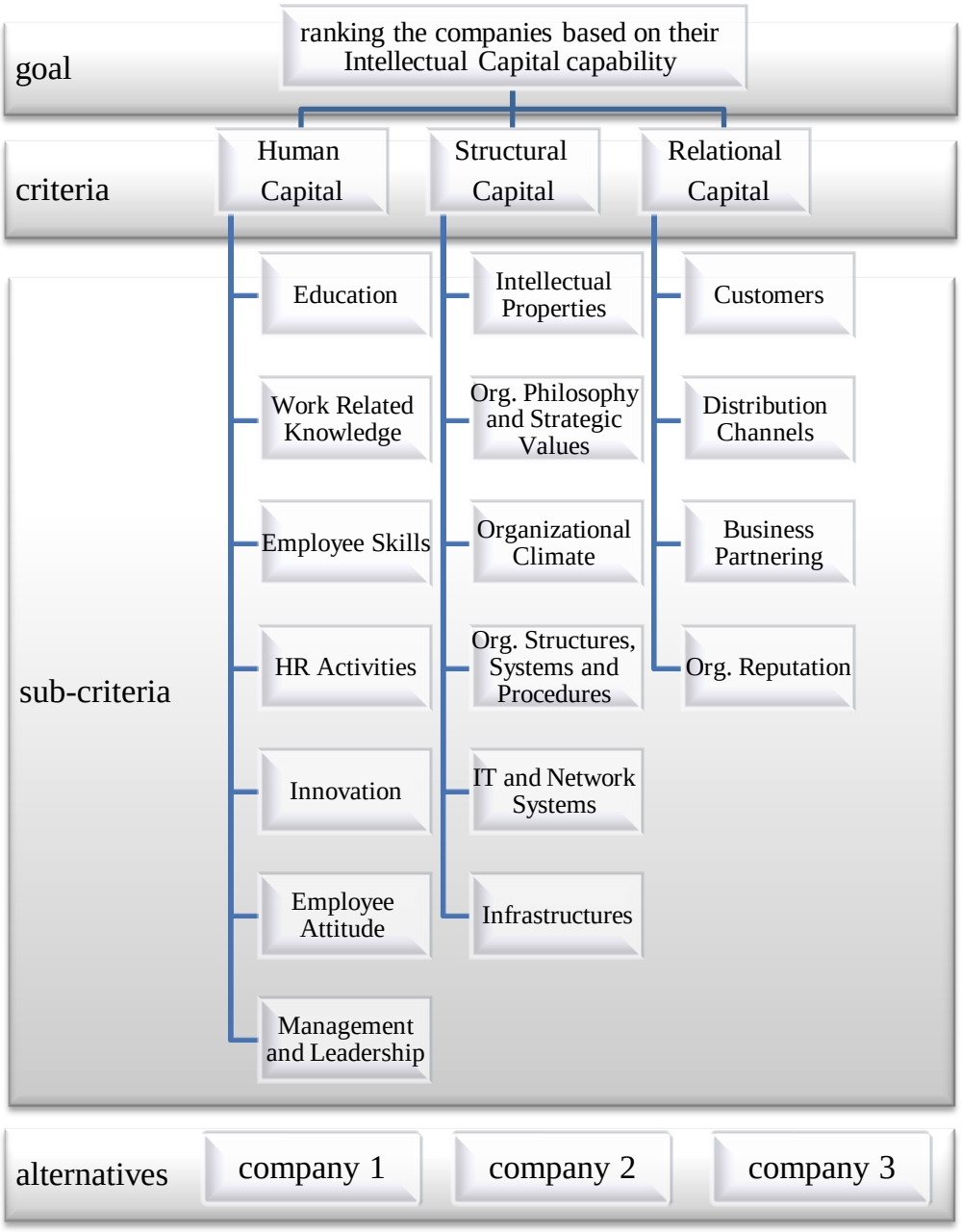


Figure 1. The conceptual framework: goal, criteria, sub-criteria and alternatives

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3.2. Fuzzy Sets and Fuzzy Numbers

Fuzzy set theory, which was introduced by Zadeh (1965) to deal with problems in which a source of vagueness is involved, has been utilized for incorporating imprecise data into the decision framework. A fuzzy set $\tilde{A}$ can be defined mathematically by a membership function $\mu_{\tilde{A}}(X)$, which assigns each element *x* in the universe of discourse *X* a real number in the interval [0,1]. A triangular fuzzy number $\tilde{A}$ can be defined by a triplet (*a, b, c*) as illustrated in Figure 2.

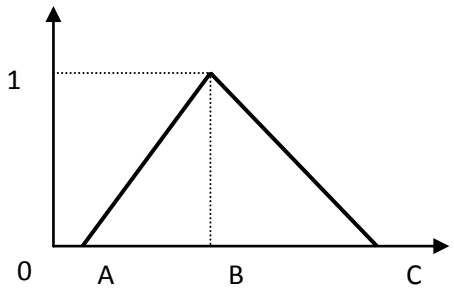


Figure 2. A triangular fuzzy number $\tilde{A}$

The membership function $\mu_{\tilde{A}}(X)$ is defined as

$$\mu_{\tilde{A}}(x) = \begin{cases} \frac{x-a}{b-a} & a \le x \le b \\ \frac{x-c}{b-c} & b \le x \le c \\ 0 & otherwise \end{cases} \quad (1)$$

Basic arithmetic operations on triangular fuzzy numbers $A_1 = (a_1,b_1,c_1)$, where $a_1 \le b_1 \le c_1$, and $A_2 = (a_2,b_2,c_2)$, where $a_2 \le b_2 \le c_2$,can be shown as follows:

Addition: $A_1 \oplus A_2 = (a_1 + a_2 ,b_1 + b_2,c_1 + c_2)$ (2)

Subtraction: $A_1 \ominus A_2 = (a_1 - c_2 ,b_1 - b_2,c_1 - a_2)$ (3)

Multiplication: if k is a scalar

$$K \otimes A_1 = \begin{cases} (ka_1 , kb_1, kc_1), & k > 0 \\ (kc_1 , kb_1, ka_1), & k < 0 \end{cases}$$

$A_1 \otimes A_2 \approx (a_1a_2 ,b_1b_2,c_1c_2)$, if $a_1 \ge 0$, $a_2 \ge 0$ (4)

Division: $A_1 \oslash A_2 \approx (\frac{a_1}{c_2} , \frac{b_1}{b_2} , \frac{c_1}{a_2})$,
if $a_1 \ge 0$, $a_2 \ge 0$ (5)

Although multiplication and division operations on triangular fuzzy numbers do not necessarily yield a triangular fuzzy number, triangular fuzzy number approximations can be used for many practical applications (Kaufmann et al. 1988). Triangular fuzzy numbers are appropriate for quantifying the vague information about most decision problems including personnel selection (e.g. rating for creativity, personality, leadership). The primary reason for using triangular fuzzy numbers can be stated as their intuitive and computational-efficient representation (Karsak, 2002). A linguistic variable is defined as a variable whose values are not numbers, but words or sentences in natural or artificial language. The concept of a linguistic variable appears as a useful means for providing approximate characterization of phenomena that are too complex or ill-defined to be described in conventional quantitative terms (Zadeh, 1975).

3.3. Fuzzy Analytic Hierarchy Process

First proposed by Thomas L. Saaty (1980), the analytic hierarchy process (AHP) is a widely used multiple criteria decision-making tool. The analytic hierarchy process, since its invention, has been a tool at the hands of decision makers and researchers, becoming one of the most widely used multiple criteria decision-making tools (Vaidya et al. 2006). Although the purpose of AHP is to capture the expert's knowledge, the traditional AHP still cannot really reflect the human thinking style (Kahraman et al. 2003). The traditional AHP method is problematic in that it uses an exact value to express the decision maker's opinion in a comparison of alternatives (Wang et al. 2007). And AHP method is often criticized, due to its use of unbalanced scale of judgments and its inability to adequately handle the inherent uncertainty and imprecision in the pairwise comparison process (Deng, 1999). To overcome all these shortcomings, fuzzy analytical hierarchy process was developed for solving the hierarchical problems. Decision-makers usually find that it is more accurate to give interval judgments than

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fixed value judgments. This is because usually he/she is unable to make his/her preference explicitly about the fuzzy nature of the comparison process (Kahraman et al. 2003). The first study of fuzzy AHP is proposed by Van Laarhoven and Pedrycz (1983), which compared fuzzy ratios described by triangular fuzzy numbers. Buckley (1985) initiated trapezoidal fuzzy numbers to express the decision maker's evaluation on alternatives with respect to each criterion Chang (1996) introduced a new approach for handling fuzzy AHP, with the use of triangular fuzzy numbers for pair-wise comparison scale of fuzzy AHP, and the use of the extent analysis method for the synthetic extent values of the pair-wise comparisons. Fuzzy AHP method is a popular approach for multiple criteria decision-making. In this study the extent fuzzy AHP is utilized, which was originally introduced by Chang (1996). Let X = {x_1, x_2, x_3,....., x_n} an object set, and G = {g_1, g_2, g_3,....., g_n} be a goal set. Then, each object is taken and extent analysis for each goal is performed, respectively. Therefore, m extent analysis values for each object can be obtained, with the following signs:

$\widetilde{M}_{g_i}^{1}$, $\widetilde{M}_{g_i}^{2}$,…, $\widetilde{M}_{g_i}^{m}$, i =1, 2,…,n

Where $\widetilde{M}_{g_i}^{j}$(j=1, 2, 3,…, m) are all triangular fuzzy numbers. The steps of the Chang's (1996) extent analysis can be summarized as follows:

Step 1: The value of fuzzy synthetic extent with respect to the ith object is defined as:

$$Si = \sum_{j=1}^{m} \widetilde{M}_{g_i}^{j} \otimes [\sum_{i=1}^{n} \sum_{j=1}^{m} \widetilde{M}_{g_i}^{j}]^{-1} \quad (6)$$

Where $\otimes$ denotes the extended multiplication of two fuzzy numbers. In order to obtain $\sum_{j=1}^{m} \widetilde{M}_{g_i}^{j}$,we perform the addition of m extent analysis values for a particular matrix such that,

$$\sum_{j=1}^{m} \widetilde{M}_{g_i}^{j} = \left(\sum_{j=1}^{m} l_j , \sum_{j=1}^{m} m_j, \sum_{j=1}^{m} u_j\right) \quad (7)$$

And to obtain $[\sum_{i=1}^{n} \sum_{j=1}^{m} \widetilde{M}_{g_i}^{j}]^{-1}$, we perform the fuzzy addition operation of $\widetilde{M}_{g_i}^{j}$ (j =1,2,…,m) values such that,

$$\sum_{i=1}^{n} \sum_{j=1}^{m} \widetilde{M}_{g_i}^{j} = (\sum_{i=1}^{n} l_i , \sum_{i=1}^{n} m_i, \sum_{i=1}^{n} u_i) \quad (8)$$

Then, the inverse of the vector is computed as,

$$\left[\sum_{i=1}^{n} \sum_{j=1}^{m} \widetilde{M}_{g_i}^{j}\right]^{-1} = \left(\frac{1}{\sum_{i=1}^{n} u_i} , \frac{1}{\sum_{i=1}^{n} m_i,} , \frac{1}{\sum_{i=1}^{n} l_i}\right) \quad (9)$$

Where u_i , m_i , l_i >0

Finally, to obtain the S_j, we perform the following multiplication:

$$S_i = \sum_{j=1}^{m} \widetilde{M}_{g_i}^{j} \otimes [\sum_{i=1}^{n} \sum_{j=1}^{m} \widetilde{M}_{g_i}^{j}]^{-1}$$
$$= \left(\sum_{j=1}^{m} l_j \otimes \sum_{i=1}^{n} l_i , \sum_{j=1}^{m} m_j \otimes \sum_{i=1}^{n} m_i , \sum_{j=1}^{m} u_j \otimes \sum_{i=1}^{n} u_i\right) \quad (10)$$

Step 2: The degree of possibility of $\widetilde{M}_2 = (l_2 , m_2 , u_2) \geq \widetilde{M}_1 = (l_1 , m_1 , u_1)$ is defined as

$$V(\widetilde{M}_2 \geq \widetilde{M}_1) = sup[\min(\widetilde{M}_1(x) , \widetilde{M}_2(y))] \quad (11)$$

This can be equivalently expressed as,

$$V(\widetilde{M}_2 \geq \widetilde{M}_1) = hgt(\widetilde{M}_1 \cap \widetilde{M}_2) = \widetilde{M}_2(d) = \begin{cases} 1 & if\ m_2 \geq m_1 \\ 0 & if\ l_1 \geq u_2 \\ \frac{l_1 - u_2}{(m_2 - u_2) - (m_1 - l_1)} & otherwise \end{cases} \quad (12)$$

Figure 3 illustrates $V(\widetilde{M}_2 \geq \widetilde{M}_1)$ for the case d for the case $m_1 < l_1 < u_2 < m_1$, where d is the abscissa value corresponding to the highest crossover point D between $\widetilde{M}_1$ and $\widetilde{M}_2$,To compare $\widetilde{M}_1$ and $\widetilde{M}_2$, we need both of the values $V(\widetilde{M}_1 \geq \widetilde{M}_2)$ and $V(\widetilde{M}_2 \geq \widetilde{M}_1)$.

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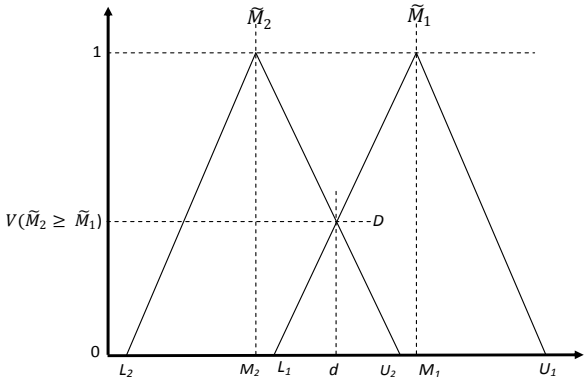


Figure 3. The intersection between M_1 and M_2 (Chang 1996)

Step 3: The degree of possibility for a convex fuzzy number to be greater than k convex fuzzy numbers M_i (i=1, 2… k) is defined as

$V(\tilde{M} \geq \tilde{M}_1, \tilde{M}_2, \ldots, \tilde{M}_k) = \min V(\tilde{M} \geq \tilde{M}_i)$, i =1,2,…,k

Step 4: Finally, $W=(\min V(s_1 \geq s_k), \min V(s_2 \geq s_k), \ldots, \min V(s_n \geq s_k))^T$, is the weight vector for k = 1,…,n.

3.4. TOPSIS

The TOPSIS method is proposed in Chen and Hwang (1992), with reference to Hwang and Yoon (1981). The basic principle is that the chosen alternative should have the shortest distance from the ideal solution that maximizes the benefit and also minimizes the total cost, and the farthest distance from the negative-ideal solution that minimizes the benefit and also maximizes the total cost (Opricovic and Tzeng, 2003). The TOPSIS method consists of the following steps:

Step 1: Calculate the normalized decision matrix. The normalized value r_{ij} is calculated as

$$r_{ij} = X_{ij} \Big/ \sqrt{\sum_{i=1}^{n} X_{ij}^2}, \forall i,j \quad (13)$$

Step 2: Calculate the weighted normalized decision matrix. The weighted normalized value v_{ij} is calculated as

$$v_{ij} = w_i r_{ij}, \forall i,j \quad (14)$$

Where w_j is the weight of the *j*th criterion, and $\sum_{i=1}^{m} w_j = 1$

Step 3: Determine the ideal and negative-ideal solution.

$$A^* = \{v_1^*, \ldots, v_m^*\} = \{(\max_i v_{ij} \,|j \epsilon C_h), (\min_i v_{ij} \,|j \epsilon C_c)\} \quad (15)$$

$$A^- = \{v_1^-, \ldots, v_m^-\} = \{(\min_i v_{ij} \,|j \epsilon C_h), (\max_i v_{ij} \,|j \epsilon C_c)\} \quad (16)$$

where C_b is associated with benefit criteria and C_c is associated with cost criteria.

Step 4: Calculate the separation measures, using the m-dimensional Euclidean distance. The separation of each alternative from the ideal solution is given as

$$S_i^* = \sqrt{\sum_{j=1}^{m} (v_{ij} - v_j^*)^2}, \forall i \quad (17)$$

Similarity, the separation from the negative-ideal solution is given as

$$S_i^- = \sqrt{\sum_{j=1}^{m} (v_{ij} - v_j^-)^2}, \forall i \quad (18)$$

Step 5: Calculate the relative closeness to the ideal solution. The relative closeness of the alternative A_i with respect to A^* is defined as

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$$RC_I^* = \frac{S_i^-}{S_i^* + S_i^-}, \forall i \quad (19)$$

Step 6: Rank the preference order.

The index values of RC_I^* lie between 0 and 1. The larger index value means the closer to ideal solution for alternatives.

4. Empirical Analysis

In this section we present a simple example in order to assess and compare the IC capability of companies in Tire industry. With this intention, we suppose three manufacturing companies in Tire industry. In this example our goal is ranking these three companies as alternatives based on their Intellectual Capital capability. Our sample decision hierarchy is illustrated in Figure 1.

Fuzzy AHP:

In Fuzzy AHP method, we determine the weights of each factor by utilizing pair-wise comparison matrixes. We compare each factor with respect to other factors. You can see the pair-wise comparison matrix for ranking of these factors in Table 2.

Table 2. Fuzzy pair-wise comparison matrix

	C_1	C_2	C_3
C_1	(1.00,1.00,1.00)	(1.00,3.00,5.00)	(0.90,1.00,2.00)
C_2	(0.20,0.33,1.00)	(1.00,1.00,1.00)	(2.00,4.00,6.00)
C_3	(0.50,1.00,1.11)	(0.17,0.25,0.50)	(1.00,1.00,1.00)

After forming fuzzy pair-wise comparison matrix, we calculate the weight of criteria. The weight calculation details are given below. The value of fuzzy synthetic extent with respect to the ith object (i = 1,2,3) is calculated as

S_1= (2.90, 5.00, 8.00) $\otimes$ (0.05, 0.06, 0.08) = (0.14, 0.32, 0.66)
S_2= (3.20, 5.33, 8.00) $\otimes$ (0.05, 0.06, 0.08) = (0.16, 0.34, 0.66)
S_3= (1.67, 2.25, 2.61) $\otimes$ (0.05, 0.06, 0.08) = (0.08, 0.14, 0.21)

Then the V values calculated using these vectors are shown in Table 3.

Table 3. V values result

(V)	S1	S2	S3
S1		1.012719	1
S2	1		1
S3	0.174823	0.144996	

Thus, the weight vector from Table 3 is calculated and normalized as

W^t = (0.4662, 0.4662, 0.0675)

TOPSIS:

The weights of criteria are calculated by fuzzy AHP up to now, and then these values can be used in TOPSIS. According to TOPSIS methodology, we obtained weighted normalized decision matrix that can be seen in Table 4.

Table 4. Weighted normalized decision matrix

	C_1	C_2	C_3
A_1	0.453	0.441	0.667
A_2	0.815	0.735	0.572
A_3	0.362	0.515	0.477

By following TOPSIS procedure steps and calculations, the ranking of companies are gained. The results and final ranking are shown in Table 5.

Table 5. Final evaluation of the alternatives

Company	S_I^*	S_I^-	RC_I^*
A_1	0.052	0.145	0.735
A_2	0.005	0.195	0.974
A_3	0.196	0.000	0.000

According to Table 5, A_2 is the best company among other companies and finally companies ranked as follow: $A_2 > A_1 > A_3$.

5. Conclusions

The main purpose of this paper is developing a model to assess the IC capability of companies in Tire industry. According to this, first by studying the literature related to intangible capitals, the main IC categories and their related indicators was recognized. Semi-structural interviews with scholars and managers of 3 companies which were going to rank based on their IC capability, validated the framework of the study and the attributes chosen as our sub-criteria. Then the weight of each IC criterion was analyzed by the fuzzy AHP method. Finally, according to these weights, the TOPSIS method was applied for the purpose of ranking companies. According to result, Company 2 is the best company among other companies.

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